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HIGH-G TESTING FOR FUZE RESEARCH

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14. ABSTRACT
The Fuzes Branch of the Air Force Research Laboratory, Munitions Directorate, has performed/instrumented numerous experiments in support of fuze development. These experiments include a wide shock spectrum ranging from relatively benign bench level experiments up to high velocity impact into multi-layered hardened structures. In this presentation we will discuss the Air Force requirements for high-g shock testing for fuze research and our testing and instrumentation capabilities.

15. SUBJECT TERMS
Fuzes, Ordnance, Shock Testing, High-g Shock, Dynamic Fuze Testing, VHG, Drop Tower, Hopkinson Bar

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High-G Testing for Fuze Research

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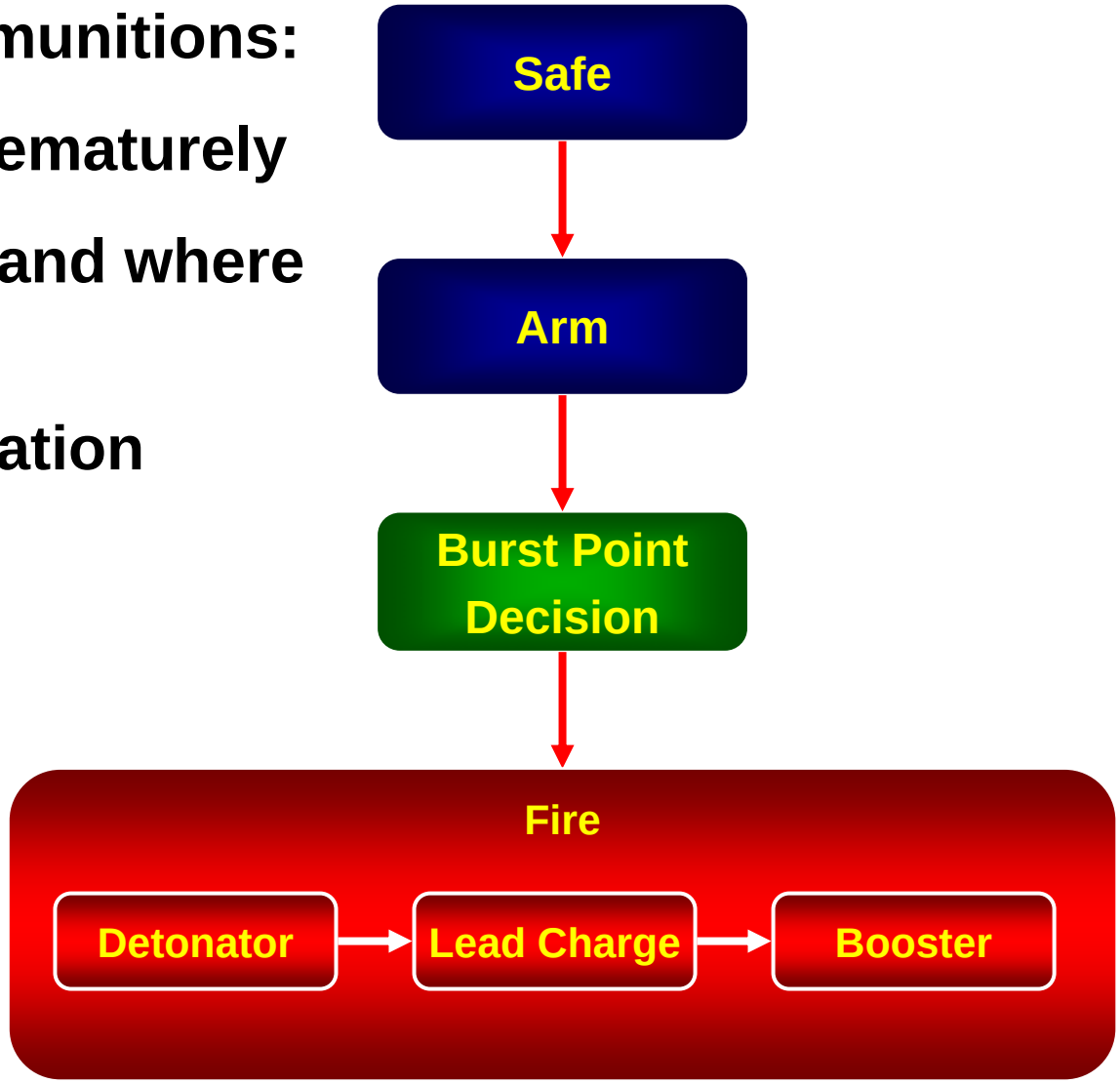
Outline

- What's a Fuze
- Requirements
- Testing Capabilities
- Challenges

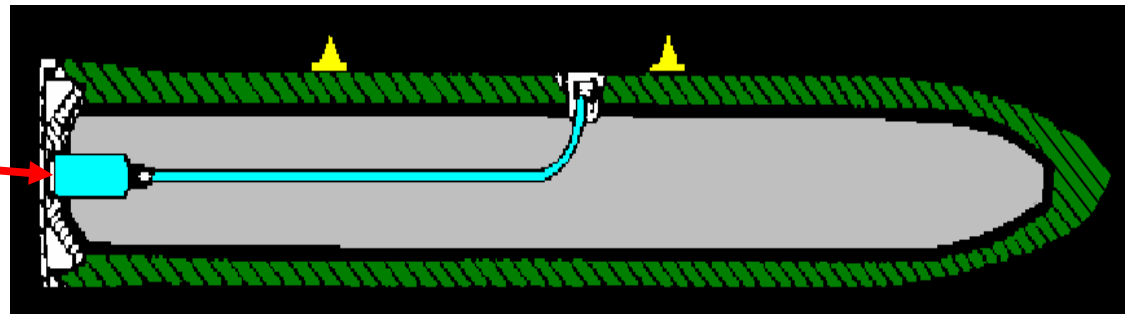
What's a Fuze

A fuze ensures that munitions:

- **Do not explode prematurely**
- **Determines when and where to detonate**
- **Initiates the detonation**



Penetrating Weapon



Penetration Fuzing

Electronic Bomb Fuze
FMU-143 B/B
Fixed Pyrotechnic Delay

Joint Programmable Fuze
FMU-152 /B
Proximity Fire, Electronic Select,
Impact Delay

Hard Target Smart Fuze
FMU-159 /B
“Smart” Void, Layer, Time…

The Future of Penetration Fuzing

- More robust
- More reliable
- Smaller
- Smarter
  - Different sensors
  - Focused initiation
- Communication
  - Between munitions
  - During impact

Guidelines

- **Safety Rules (MIL-STD 1316)**
  - **Explosives**
  - **Environmental Sensors**
  - **Arming**
  - **Safe Separation**
  - **Launch**
- **Safety rules evaluated in context of each Munition System**
  - **e.g. safe separation for AMRAAM different than Mk-82 bomb**
- **Rules applied depending on explosive train design**

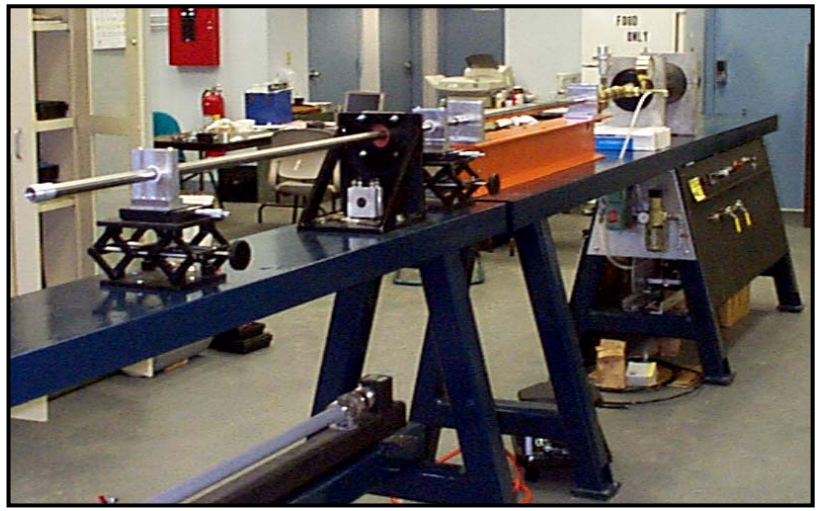
The Problem At Hand

- **Understand the acceleration environment**
  - **Lower frequencies to determine rigid body response for development of burst point control fuzing**
  - **Higher frequencies to define the environment the fuze must survive**
- **Create realistic environments; known and repeatable**
- **No Mil Std for shock survivability, outside of transportation**

Testing Capabilities for Shock

- **Dynamic Shock Facility**
  - **Hopkinson Bar**
  - **Drop Tower**
  - **Very High G (VHG) Machine**
  - **Centrifuge**
- **Field Testing**
  - **Cannon**
  - **Sled Track**
  - **Air-Delivered**

Hopkinson Bar



- **Attributes:**
  - **Air driven impactor**
  - **1 in. diameter titanium bar**
  - **Programmers used to shape leading edge of pulse**
- **Used for:**
  - **Instrumentation Studies**
  - **Material Properties Testing**
    - **Shock-isolation materials & techniques**

Drop Tower

- **Attributes:**
  - **Drop heights up to 10 ft.**
  - **Free fall or driven with a bungee cord**
  - **Programmers used to shape pulse**
  - **Payload – 25 lbs**
- **Used for:**
  - **Component Testing**
  - **Full-up Fuze**

Very High G (VHG) Machine

- **Attributes:**
  - **Air driven 10 lbs impactor**
  - **Payload – 10 lbs**
  - **Pulse shaped using:**
    - **Different anvil materials**
    - **Programmers**
- **Used for:**
  - **Instrumentation Studies**
  - **Component Testing**
  - **Full-up Fuze**

Centrifuge

- **Attributes:**
  - **20-30 kg**
  - **Payload – 5 lbs**
  - **Long-duration high-g testing**
  - **RF data transmission**
- **Used for:**
  - **Instrumentation Studies**
  - **Component Testing**

Cannon Testing

- Attributes:
  - Howitzer Cannons
    - various barrel sizes
    - Smooth bore and rifled
  - Projectiles
    - OD 3.6 - 8 in.
    - Weight between 25 – 250 lbs
  - Targets
    - 4 in. thick to 4 ft thick
    - 30 in. dia. to 7 ft x 9 ft
    - Single or multi-layer configurations
- Used for:
  - Full-up Fuze
  - Component Testing
  - Instrumentation Studies

Sled Track

- **Attributes:**
  - **2000 ft long**
  - **Velocities > 2000 fps for a 2000 lb item**
  - **Unlimited target size**

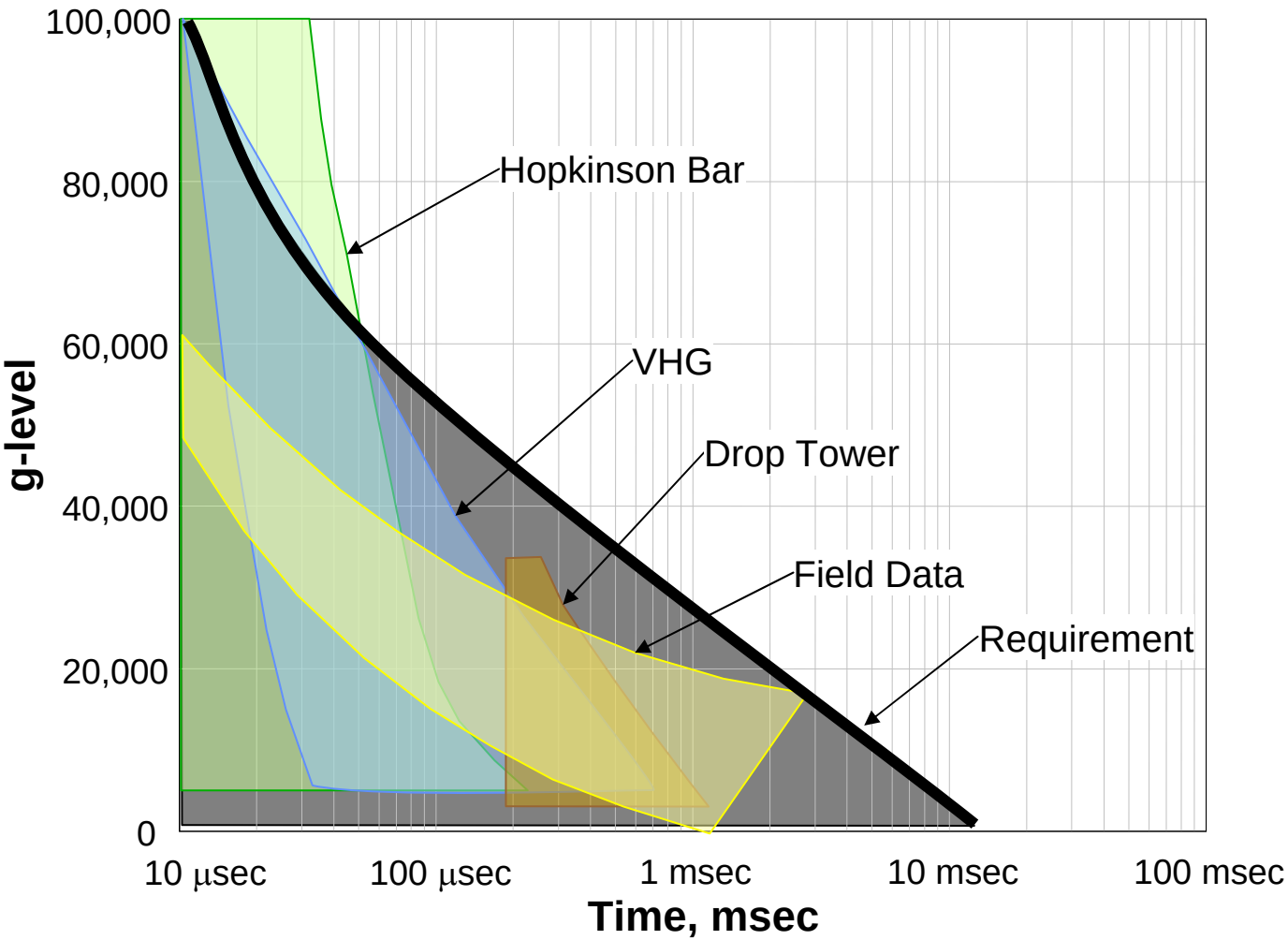
- **Used for:**
  - **Full-up Fuze**
  - **Full-scale weapon (integration) testing**

Air-Delivered

- **Attributes:**
  - **Realistic missions**
  - **Realistic environment**

- **Used for:**
  - **Full-up fuze**
  - **Full-scale weapon system (integration) testing**

Objective vs. Capabilities



Challenges

- Can’t afford to conduct just field tests (nor is it appropriate)
- Currently limited to 1-D environments in the lab
- Experience has shown that to survive a sled test an entire suite of tests must be conducted in the lab, e.g.,
  - Normal
  - Reverse
  - Lateral at varying angles (0, 45, 90, etc.)

Summary

- Changing requirements
  - More severe environments
  - Perform additional functions
- Combination of lab/field tests required
- Interesting testing and instrumentation challenges remain
  - Realistic environments
  - Testing techniques
  - Accurate, robust instrumentation